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AUTHOR Boyle, Gloria J.; Herrick, Merlyn C.
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ABSTRACT

This progress report concerns an audio-tutorial approach used at the University of Missouri-Columbia School of Medicine. Instructional techniques such as slide-tape presentations, compressed speech audio tapes, computer-assisted instruction (CAI), motion pictures, television, microfiche, and graphic and printed materials have been implemented, with the learner in mind, throughout the four years of medical school. With the increase in software and the need to provide self-evaluation capabilities, equipment was adapted or developed to fulfill this goal. The electric board enables the student to assess his mastery of the material in slide-tape presentations, the Didactor-Slidemate presents or evaluates programs with the aid of color slides or photomicrographs. The Path-Printer provides a record of the student's path through the learning program. (Author/CP)

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AUDIO-TUTORIAL INSTRUCTION IN MEDICINE

A Progress Report

Gloria J. Boyle, M.Ed.
Merlyn C. Herrick, Ed.D.
School of Medicine
University of Missouri-Columbia
Columbia, Missouri 65201

As was reported at the first annual audio-tutorial conference, the University of Missouri-Columbia School of Medicine is engaged in an audio-tutorial approach that emphasizes the learner. With the learner in mind, instructional techniques such as slide-tape presentations, compressed speech audio tapes, computer-assisted instruction (CAI), motion pictures, television, microfiche, and graphic and printed materials have been implemented throughout the four years of medical school. Before discussing the specific developments that have taken place in the last two years, it is necessary to describe some of the physical and curricular features that are endemic to the medical student at Missouri. With increasing enrollments, lack of laboratory space, and a need to individualize instruction, the multidisciplinary laboratory was brought into being for the first- and second-year students. 100 students per class are divided into 16-man laboratories. These laboratories provide the student with individual study and laboratory space and act as a self-contained unit. With this physical arrangement, these laboratories lend themselves well toward self-instruction. Anatomy, Pathology, Pharmacology, Introduction to Medicine, and Microbiology utilize a variety of the instructional modalities available as a part of their curricula. With the advent of the multi-disciplinary laboratory, the audio-tutorial approach came into its own at the School of Medicine in 1968. At that time, our main interests were CAI, the production of slide-tape presentations, and experimentation with compressed speech audio tapes. These topics were discussed fully at a similiar conference in 1969. (Copies of the 1969 paper are available upon request.)

While the emphasis in 1969 was the presentation of materials, the emphasis in 1971 is self-assessment of these materials. Today's student has become more responsible for his learning. He is aware of behavioral objectives, and often requests that these objectives be verbally stated. Armed with the knowledge of what he is to learn, the student now wants to know if he has learned. Three devices have been designed to provide the student with self-assessment capabilities.

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The simplest self-assessment instrument is an adaptation of the electric board, long known to the elementary teacher. Pictures of the external and internal components of the electric board are found on pages 7 and 8. As an extension of the slide-tape presentation, the electric board provides immediate reinforcement over the slide-tape material. Due to the complexity of the material that a medical student is required to master, the electric board has been increased in sophistication to handle a variety of self-assessment techniques. Self-evaluation questions are typed on legal-size paper to fit 24 possible choices. These sheets can then be programmed to handle matching, multiple choice, and panel identification questions. Some of the varieties of questions and the corresponding circuitry are included at the end of this paper. With matching and panel identification questions, it was necessary to devise an electric board that could handle one answer per question. Page 9 shows an example of a Neurology evaluation which utilizes matching phrases. The Myology evaluation on page 10 is a series of multiple choice questions with one correct answer. Page 11 utilizes the matching technique in combination with a panel identification and listing of possible structures. Again, there is one correct answer for each question. Through the use of multiple position switches, we are able to change the keys so that no pattern of responses becomes too familiar.

For those multiple choice questions which require more than one answer, snap-on connectors complete the circuit between question and correct answer. Thus, an evaluation sheet of 12 questions could be wired as shown on page 12. It has been necessary to use double throw push button switches for those questions which have a combination of the same answer, a discreet answer, or more than one answer. The circuitry for this type of board is illustrated on page 13. The student may use these self-evaluation sheets as a pre-test or post-test in conjunction with the slide-tape presentation. Used as a pre-test, the student might find that he knows most of the answers and that his valuable time might be well-spent in some other learning activity. Used as a post-test, the student receives immediate reinforcement on his acquisition of subject matter.

The second self-assessment device is an addition to the Didactor system (CAI)—the Slidemate. One should keep in mind that the computer-type device, the Didactor, has the following capabilities:

1. Displays branching and linear programs.
2. Puts the student under a time pressure.
3. Remembers student errors and adjusts the program to meet his responses.

Information is typed on 4 x 6 cards, digitally coded for the light-sensitive Didactor computer, and then photographed on microfilm. Page 14 includes a sample Didactor card, the corresponding coding, and the final product, a microfilm strip.

The Slidemate enables the Didactor to present a synchronized program with both verbal and visual elements. The program provides an opportunity for correct and incorrect answers with immediate reinforcement and remedial instruction enhanced by the appropriate color slide or photomicrograph. The Slidemate functions equally in two roles. As a part of the Didactor system, it can present or it can evaluate. For instance, in one program entitled Ordering and Taking of Chest X-Ray Films, it is necessary for the student to be able to read and interpret x-rays. Standard views such as posteroanterior, lateral, and anterior oblique are introduced in the following manner:

The right anterior oblique view (also known as right PA oblique) is an upright film with the patient's right shoulder against the film and his body turned approximately 45 degrees from the film. Again the x-ray beam passes PA from a distance of 6 feet.

Press A

One can see by the nature of the material that this verbal frame needs a visual element. Thus, with the aid of the Slidemate, a slide of the patient and central ray provides the student with a concept of the physical arrangement when taking a right anterior oblique x-ray. This slide is followed by an x-ray of the right anterior oblique with the Didactor providing the descriptive narrative. Thus, the Slidemate aids in presenting material.

After introducing the standard x-ray views, the student is given the following problem:

> Here is a PA film in which we see a bullet in the area of the right hemithorax. There is a suggestion of "blunting" (loss of the normal costo-phrenic angle) at the right base (arrow). We might naturally suspect there is a hemothorax or pleural effusion following trauma, if the bullet passed through the thorax.
>
> What additional films would you order to help you evaluate the presence of this fluid?
>
> A. Right lateral
> B. Right anterior oblique
> C. Right lateral decubitus
> D. Left lateral decubitus

A visual is needed for the question and the four possible answers. This frame indicates the evaluation role of the Slidemate. The Slidemate can provide evaluation capabilities in another manner. After a student completes a slide-tape presentation using a slide projector and a tape recorder, he may then go to the Didactor system for self-assessment. For instance, after completing the program, Examination of the Blood Smear and Differential White Cell Count, the student can use the Didactor-Slidemate to test his ability to identify unknown cells in a blood smear.

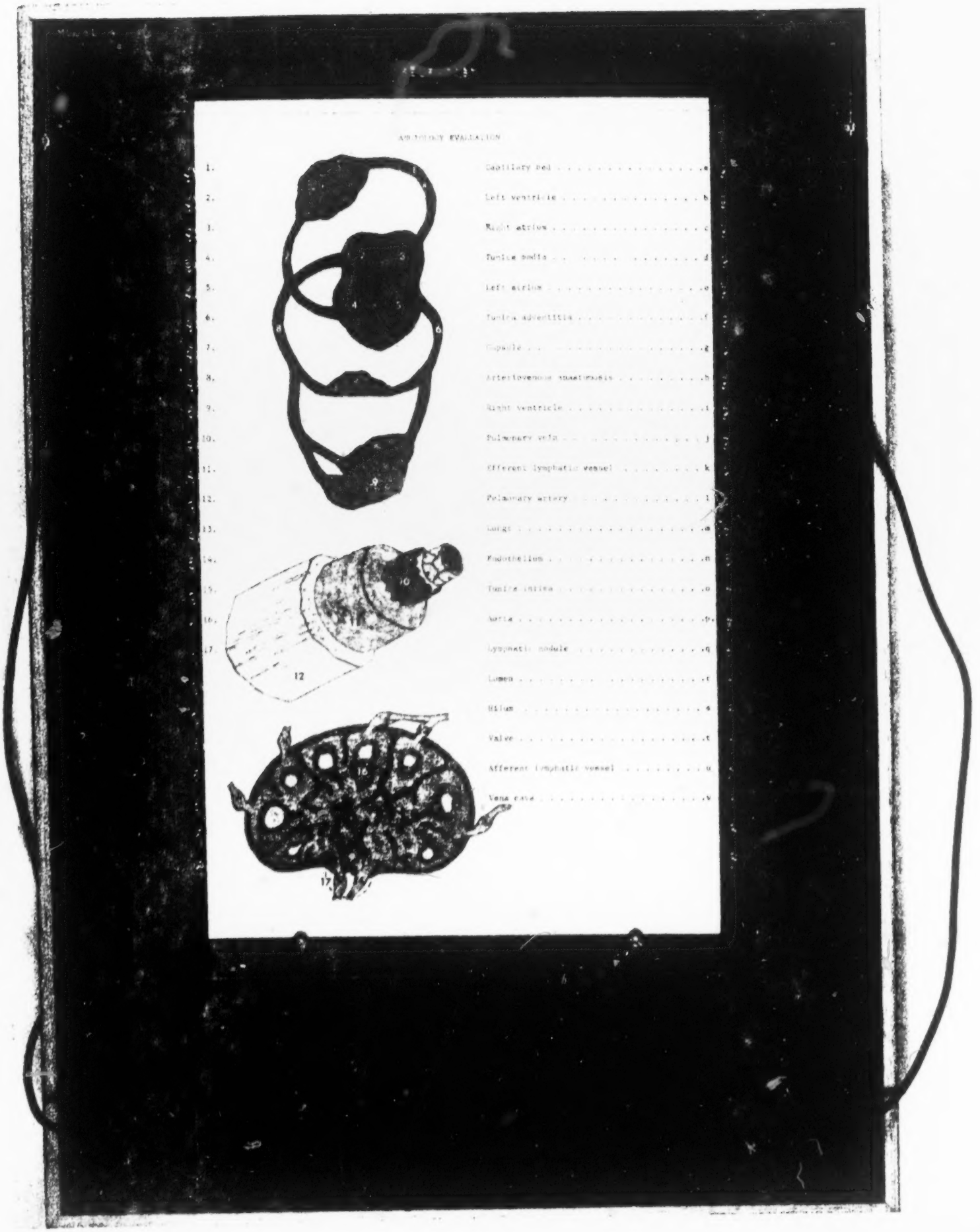
Up to this point, the two self-assessment tools that have been described evaluate factual material. No one will deny the medical student's need for facts, but these facts must be interdigitated with the ability to make judgments. To evaluate the student's problem-solving skills, it was necessary to develop an instrument that would record the student's path through the learning program. Such a need prompted the development of the Path-Printer, another addition to the Didactor system. In the education of a physician, it is important that the student-doctor work with as many patient problems as possible. A very economic way to give the student control of a patient is to simulate a patient. This simulated patient is the vehicle for providing dialogue with the Didactor system. The student takes the patient history, queries the patient, and makes decisions concerning treatment, therapy, and follow-up. In the program entitled Patient Management it is important for the teacher-doctor to be aware of the path of responses a student makes. Too many questions, not enough questions, or the type of questions all reflect the student's ability to respond as a knowledgeable diagnostician.

The Path-Printer is a counter which prints the frame number of each frame the student selects. A strip of the Path-Printer tape is found at the bottom of page 14. The student began with frame #1, then advanced to #2. At frame #2, he was given several choices. Knowing the correct answer, he advanced to #10. Frame #10 also contained a choice. At this point, the student responded incorrectly revealing a lack of understanding of the material contained in frames #5 through #9. Thus, by answering incorrectly #10, the Didactor system provided remedial instruction in frames #7 and #8. When the student advanced to #10 again, he responded with the correct answer and continued out of this bottleneck to frame #11. At the conclusion of the exercise, this strip of tape provides a non-graded record of the student's responses. The value of such a record is two-fold. First, it can evaluate the effectiveness of the student's strategies. Secondly, it can evaluate the effectiveness of the simulated program.

In summary, in the last two years there has been more emphasis on the production of programs for the system identified in 1969. With the increase in software and the need to provide self-evaluation capabilities, equipment such as the electric board, Didactor-Slidemate, and Path-Printer was adapted or developed to fulfill these goals. The electric board enables the student to assess his

mastery of the material in slide-tape presentations. The Didactor-Slidemate presents or evaluates programs with the aid of color slides or photomicrographs. The Path-Printer provides a record of the students' path through the learning program. With the addition of these three devices, we are better able to meet the needs of today's medical student.

EDUCATIONAL RESEARCH & DEVELOPMENT


ANATOMY EVALUATION
1. Capillary bed . . . . . a
2. Left ventricle . . . . . b
3. Right atrium c
4. Tunica media . . . . . d
5. Left atrium . . . . . e
6. Tunica adventitia . . . . . f
7. Capsule . . . . . g
8. Arteriovenous anastomosis . . . . . h
9. Right ventricle i
10. Pulmonary vein . . . . . j
11. Efferent lymphatic vessel . . . . . k
12. Pulmonary artery l
13. Lungs . . . . . m
14. Endothelium . . . . . n
15. Tunica intima . . . . . o
16. Aorta . . . . . p
17. Lymphatic nodule . . . . . q
Lumen . . . . . r
Hilum . . . . . s
Valve . . . . . t
Afferent lymphatic vessel . . . . . u
Vena cava v
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2
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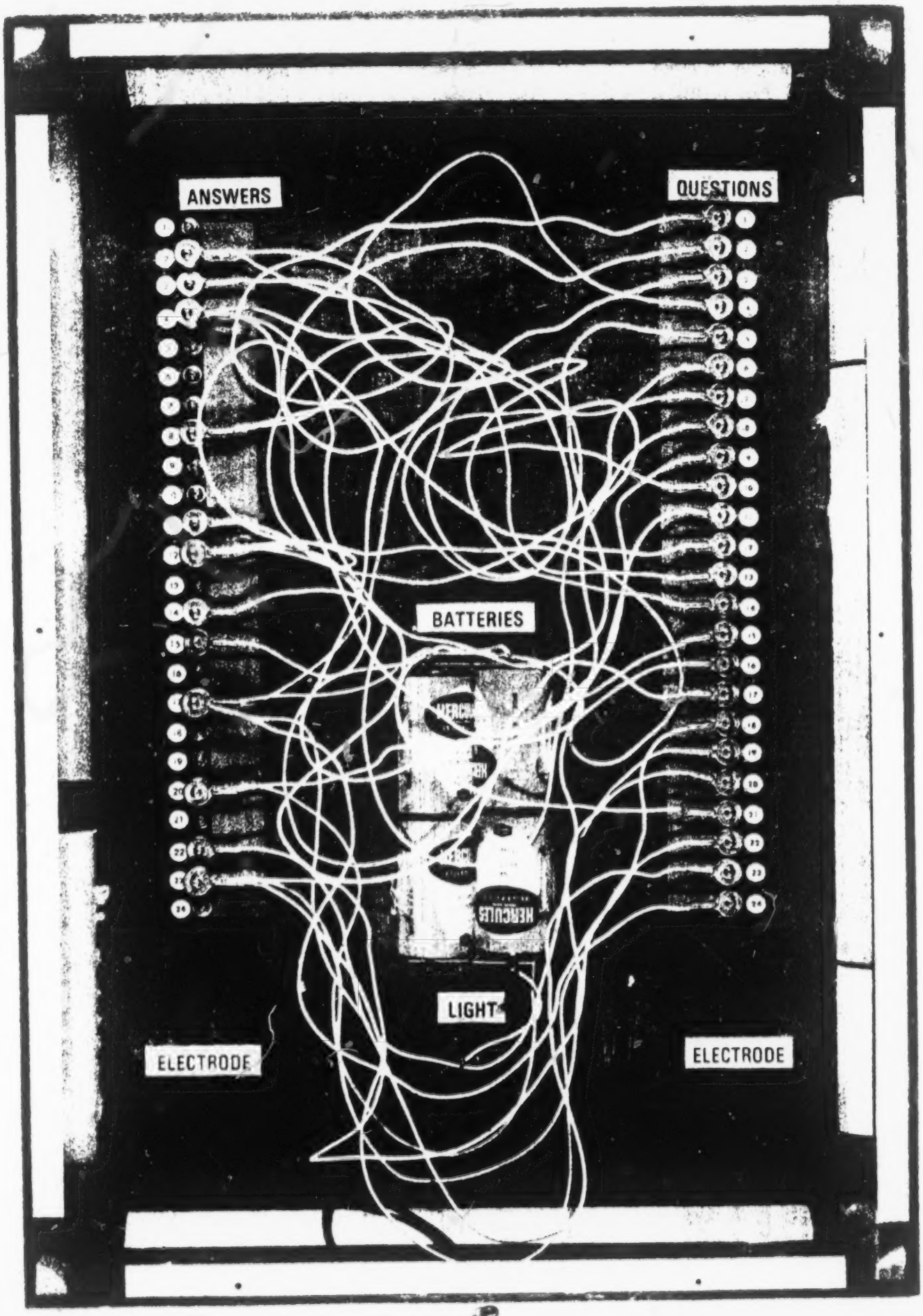
17


ANSWERS
QUESTIONS
BATTERIES
LIGHT
ELECTRODE
ELECTRODE

NEUROLOGY EVALUATION

1. A lesion of the mixed spinal nerve leads to:
2. The internuncial neuron is interposed in the:
3. The motor territory of a mixed spinal nerve is referred to as a:
4. The autonomic division of the nervous system innervates:
5. The parasympathetic division is known as the:

Preaortic ganglia . . . . . a.

Quiescent state . . . . . b.

Multisynaptic arc . . . . . c.

T_2 to L_1 . . . . . d.

Myotome . . . . . e.

Ciliary ganglia . . . . . f.

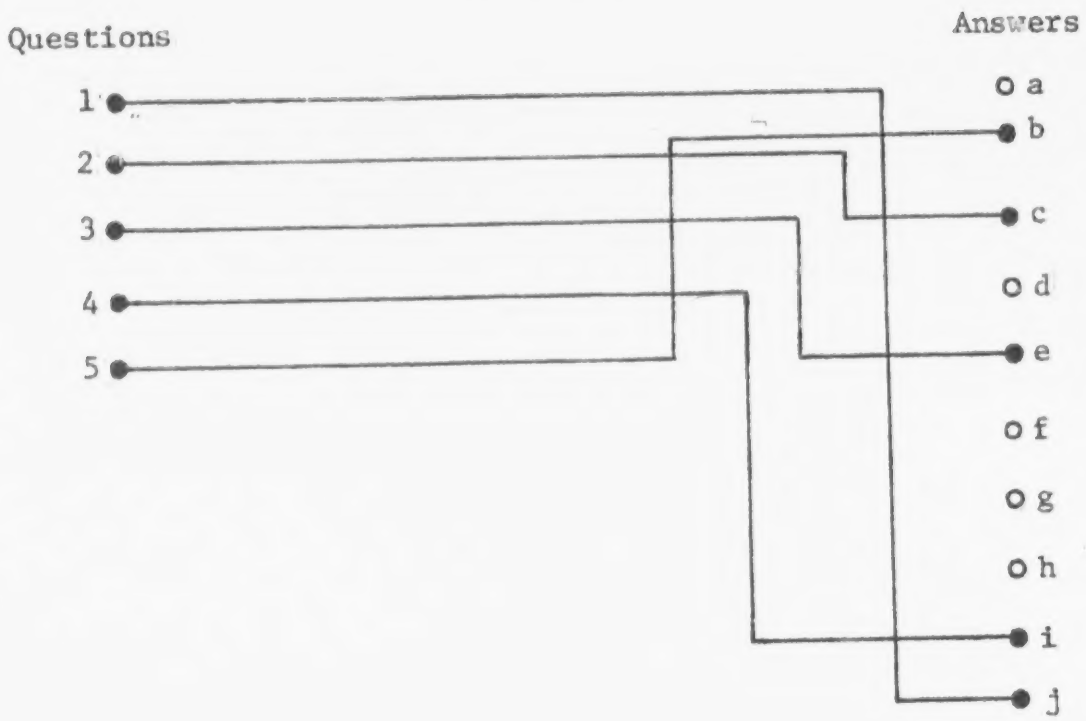
Skin and skeletal muscle . . . . . g.

"Flight or fight" state . . . . . h.

Glands . . . . . i.

Partial paralysis . . . . . j.

CIRCUITRY



MYOLOGY EVALUATION

1. Which type of muscle fiber is not regulated by the autonomic nervous system?

Skeletal . . . . . a.

Smooth . . . . . b.

Cardiac . . . . . c.

2. A skeletal muscle is composed of fascicles, bound together by the:

Endomysium. . . . . .a.

Perimysium . . . . . b.

Epimysium . . . . . c.

3. The parallel fibers in muscles may be:

Quadrate, strap-like,. . a.
fusiform, or triangular

Quadrate, strap-like, . .b.
or fusiform

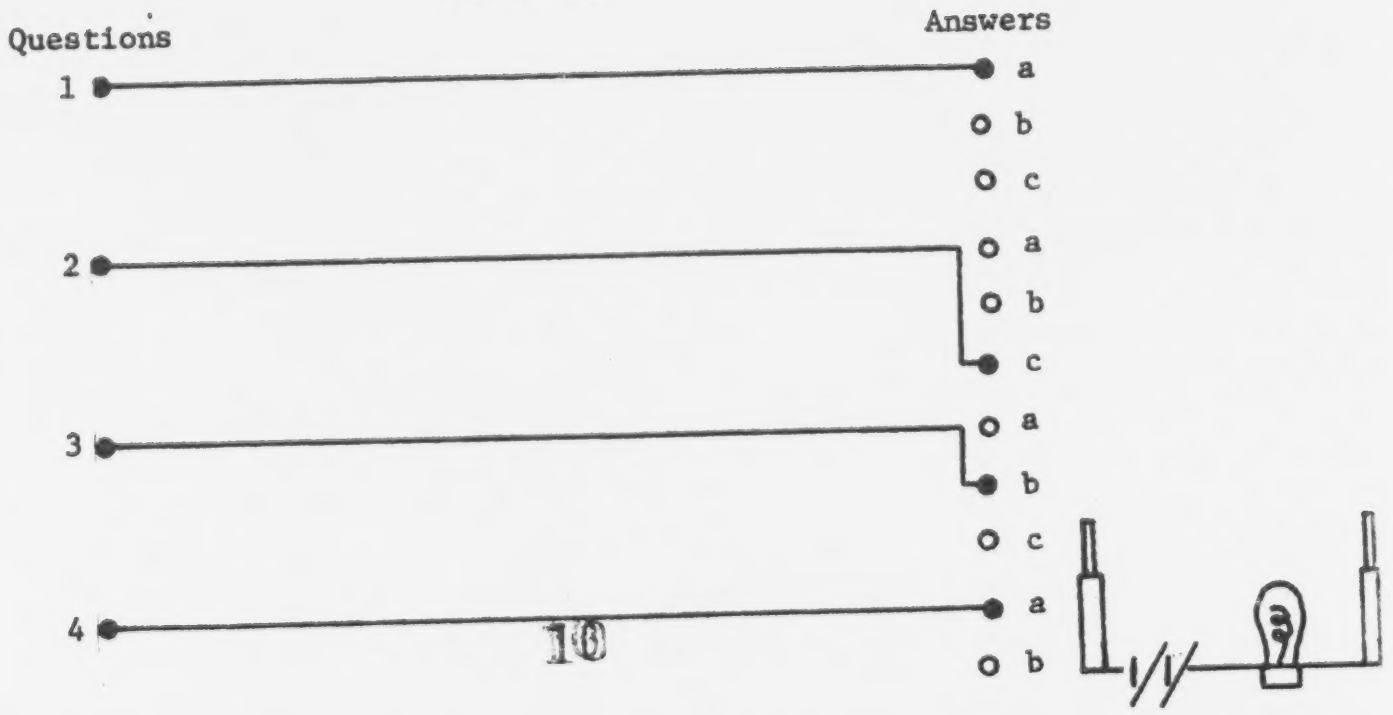
Quadrate, strap-like . . c.
fusiform, triangular, or
pennate

4. The fibers of temporalis are:

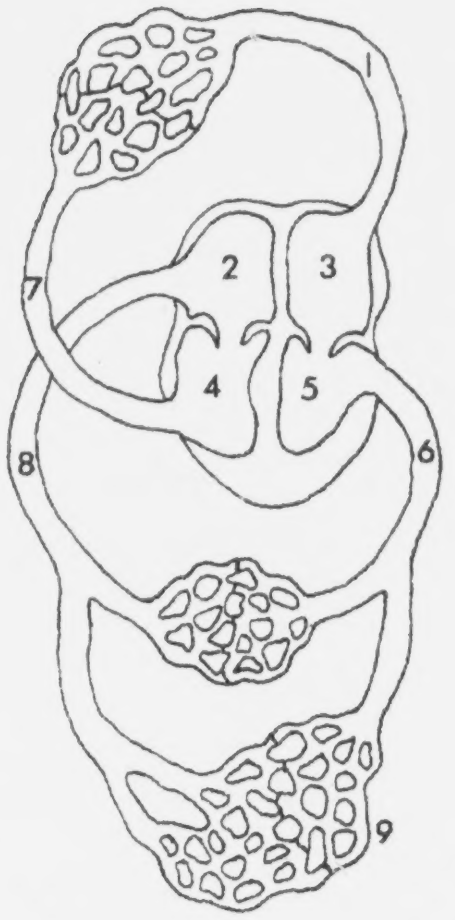
Triangular . . . . . a.

Pennate . . . . . b.

CIRCUITRY

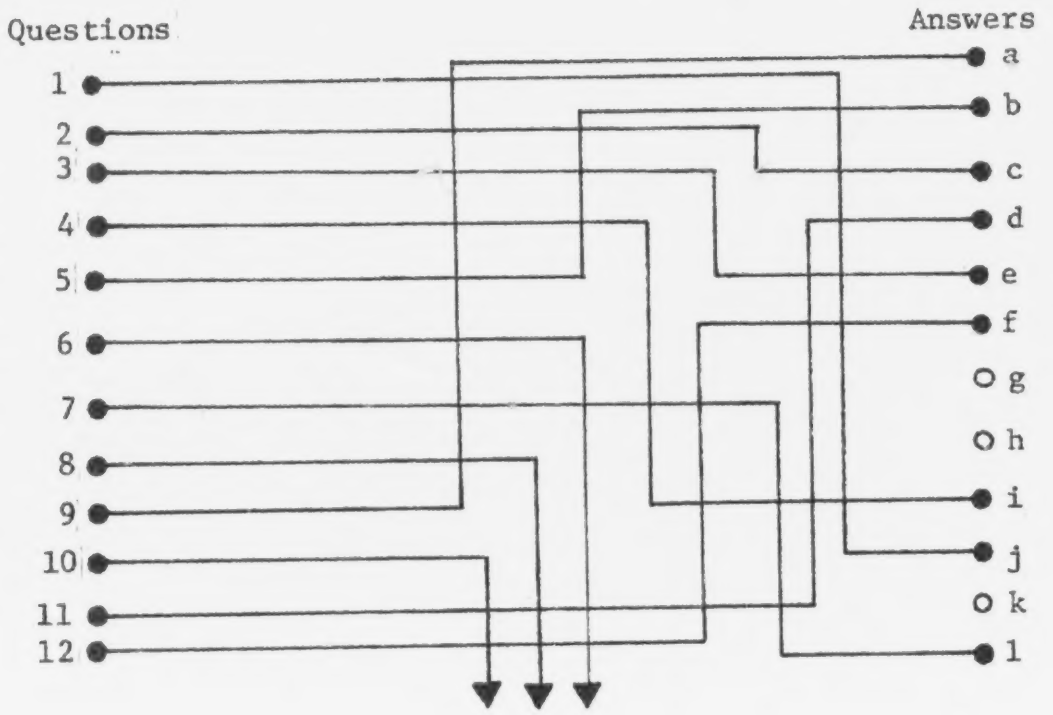


ANGIOLOGY EVALUATION

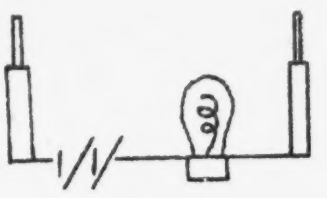


1.	Capillary bed . . . . . a.
2.	Left ventricle . . . . . b.
3.	Right atrium . . . . . c.
4.	Tunica media . . . . . d.
5.	Left atrium . . . . . e.
6.	Tunica adventitia . . . . . f.
7.	Capsule . . . . . g.
8.	Arteriovenous anastomosis . . . . . h.
9.	Right ventricle . . . . . i.
10.	Pulmonary vein . . . . . j.
11.	Efferent lymphatic vessel . . . . . k.
12.	Pulmonary artery . . . . . l.

CIRCUITRY



11



ARTHROLOGY EVALUATION

1. Atlanto-axial
2. Gomphosis
3. Intervertebral
4. Tibiofibular syndesmosis
5. Interphalangeal
6. Intercarpal

CLASSIFICATION OF JOINTS

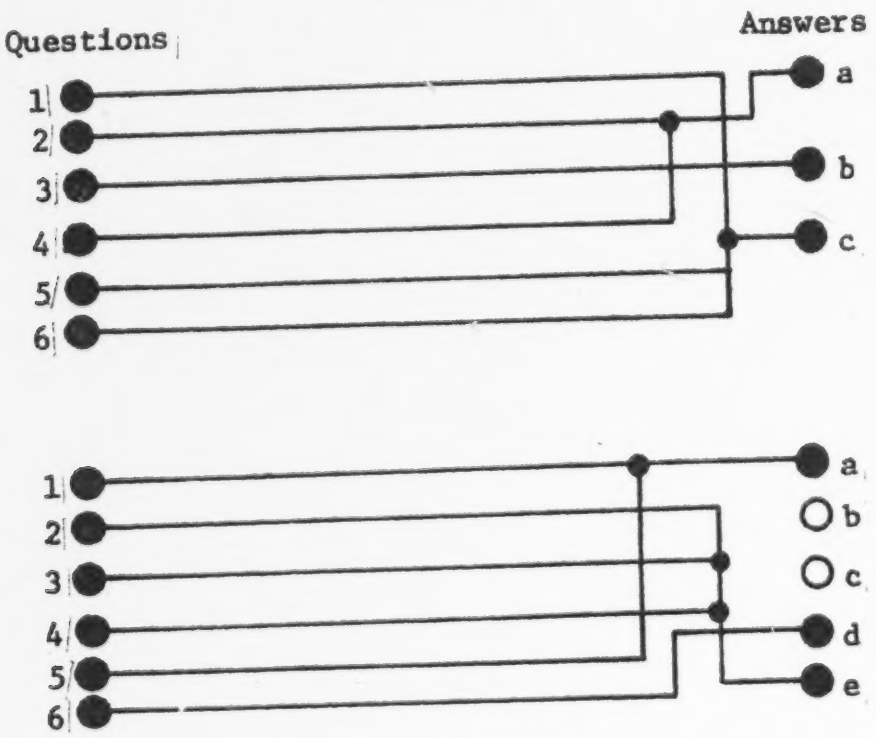
Fibrous . . . . . a.
Cartilaginous . . . . . b.
Synovial . . . . . c.

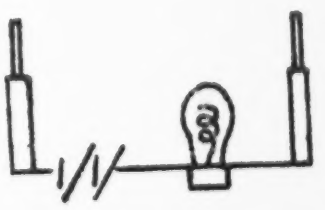
1. Atlanto-axial
2. Gomphosis
3. Intervertebral
4. Tibiofibular syndesmosis
5. Interphalangeal
6. Intercarpal

TYPES OF SYNOVIAL JOINTS

Uniaxial . . . . . a.
Biaxial . . . . . b.
Polyaxial . . . . . c.
Plane . . . . . d.
None of these . . . . . e.

CIRCUITRY





ARTHROLOGY EVALUATION

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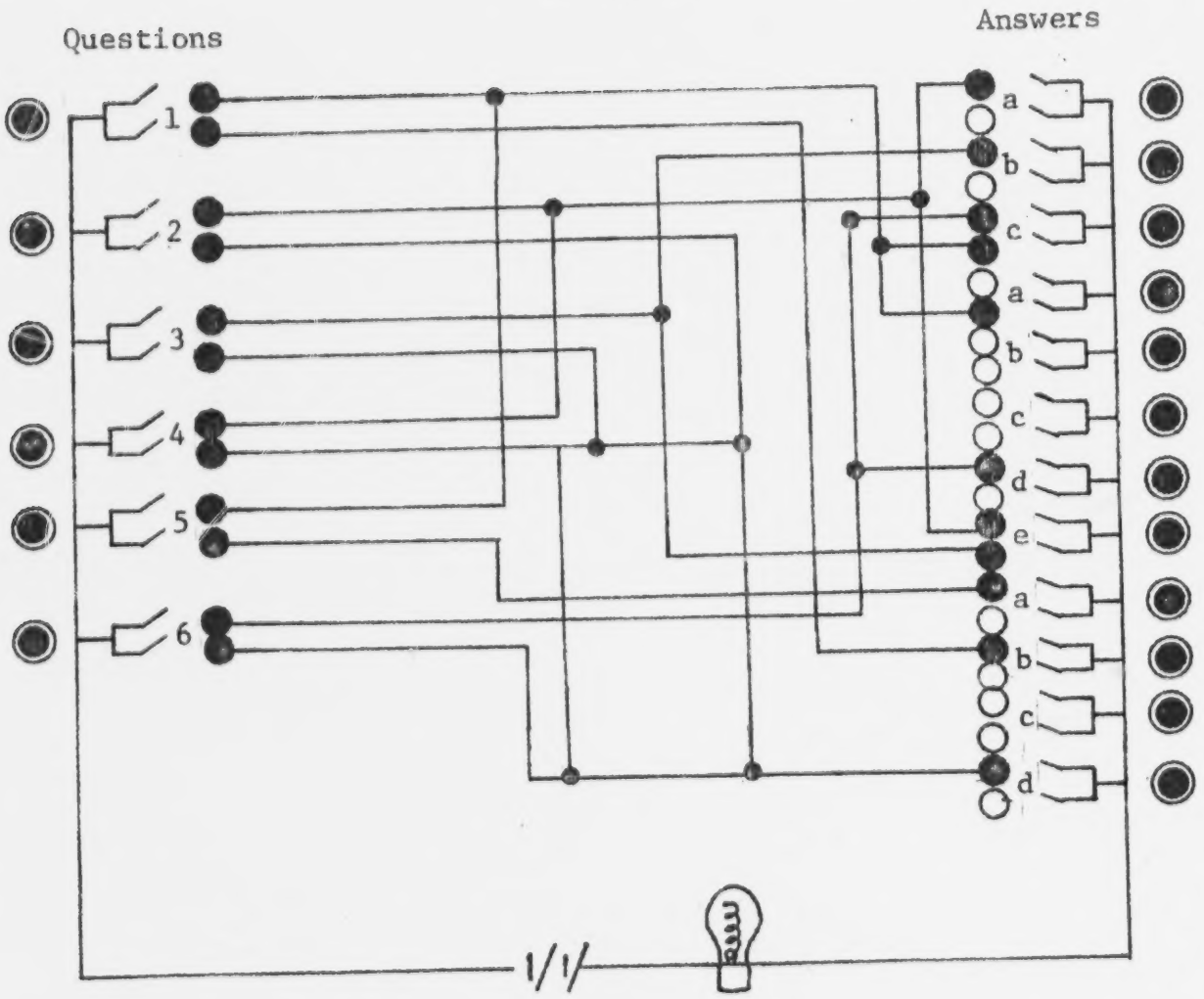
TYPES OF SYNOVIAL JOINTS

Uniaxial . . . . . a.
Biaxial . . . . . b.
Polyaxial . . . . . c.
Plane . . . . . d.
None of these . . . . . e.

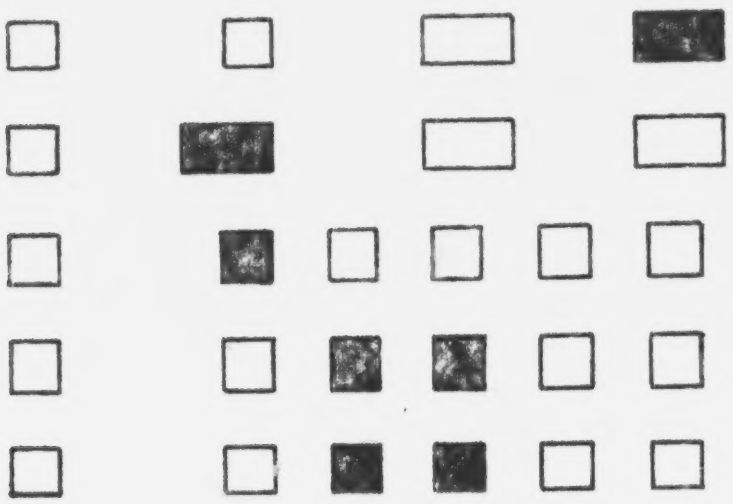
MOVEMENTS

Flexion and extension about horizontal axis . . . a.
Rotation about vertical axis . . . . . b.
Abduction and adduction about horizontal axis . . c.
None of these . . . . . d.

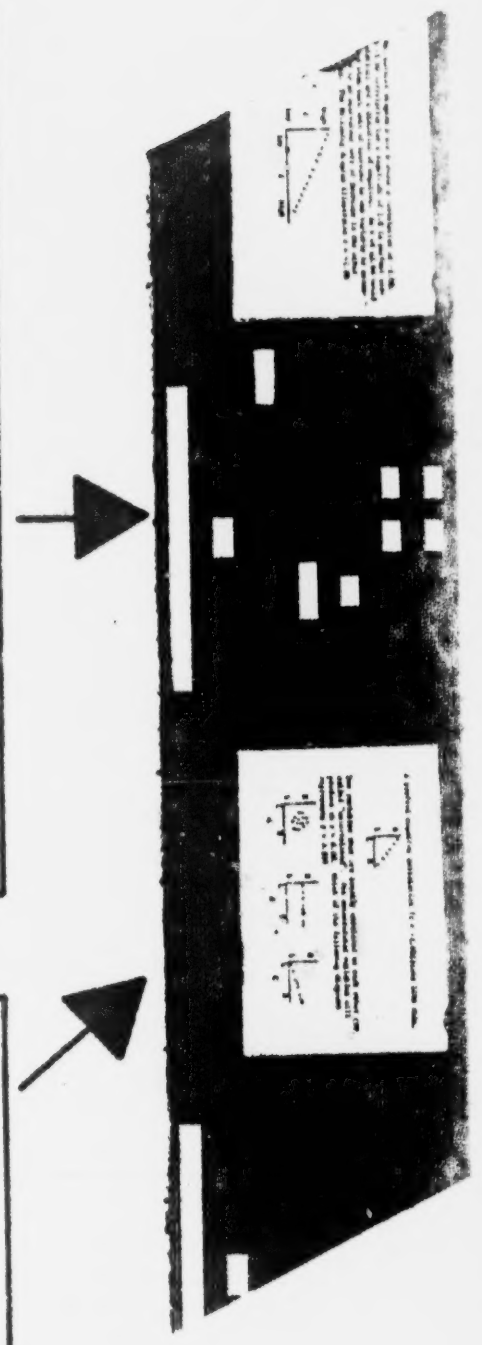
CIRCUITRY



DIDACTOR CODING

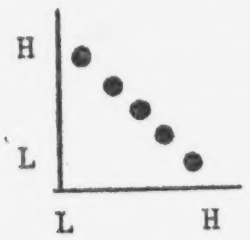


MICROFILM

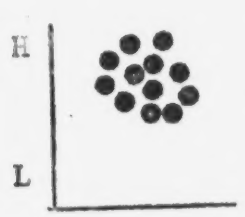


DIDACTOR SAMPLE CARD

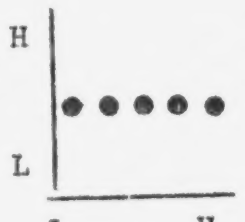
A perfect negative correlation (r = -1.00) looks like this.



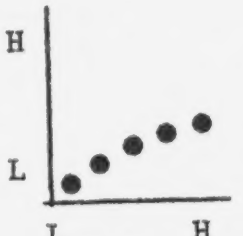
Two variables that are totally unrelated to each other are called "uncorrelated". Two uncorrelated variables will produce an r = 0.00. Which of the following diagrams represents r = 0.00?



(A)



(B)



(C)

DIDACTOR PATH-PRINTER

01S
02S
10S
07S
08S
10S
11S